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PREFACE

Industrial training is a wide issue in engineering education. It is an indispensable element of every engineering course. It is also an important aspect in continuing education.

Engineering education can only be successful through appropriate integration of theory and practice, such that graduates are able to generate ideas and put them into work; able to handle real industrial problems; able to make technical decisions; and, at a later stage of their career life, able to make managerial and business decisions. Properly planned and implemented industrial training is essential to ensure these qualities of engineering graduates.

In order to provide opportunities for exchanging ideas and experiences in modern industrial training, the first Conference on Modern Industrial Training (CMIT1) was jointly organized by South China University of Technology and the Hong Kong Polytechnic and was held in Guangzhou in May 1986. CMIT2 was jointly organized by Nanjing Aeronautical Institute and the Hong Kong Polytechnic and was held in Nanjing in Nov 1988. The current Conference (CMIT3) is jointly organized by Huazhong University of Science and Technology and the Hong Kong Polytechnic, and the topics include:

1. Industrial training philosophies.
2. The role of industrial training in high level engineering education.
3. Training course content: introductory, standard, and high-tech elements.
4. Planning and management of training centres.
5. Staffing of training centres. Training and staff development of trainers.
6. Safety education and psychological aspects.
7. Continuing education to meet training needs.
8. Pre-employment training.
9. Modes and methods of training.
10. Use of modern educational techniques and visual aids in training.
11. Development of training material.
12. Cooperation between educational institutes and industry in training.

The importance of modern industrial training is well accepted. Training is particularly important in this era of rapid technological advancement. It is a mission for all who are involved in tertiary and continuing engineering education to investigate, develop, review and implement relevant training programmes to cope with the ever changing technology.

Nearly 80 papers from about 100 authors from China, Hong Kong territory and overseas countries are included in this Conference Proceedings. Valuable ideas and experiences are expressed and these will definitely have significant impacts on various aspects of training. It is anticipated that these papers will serve as catalysts and will provide food for thought so that more ideas and developments will evolve in the future.

The editors would like to express their deep appreciations to all contributing authors, to Huazhong University of Science and Technology for organizing and hosting the Conference, to Hong Kong Polytechnic for jointly organizing the conference, to all initiating institutes, and to the Huazhong University of Science and Technology Press. Without the cooperation of all these parties this Conference Proceedings, and the Conference itself, would not have been possible.

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CONTENTS

OPENING UP THE FUNCTION AT PRACTICE TEACHING AT THE ATTACHED UNIVERSITY-RUN FACTORY

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ABSTRACT

The paper introduces the newly developed practice teaching system in Tsinghua University which is divided into three stages. The first stage is "Manufacturing Practice" and "Electronics Practice"; The second stage is "Technological Operating Techniques" elective course and the activity of work-study programme; The third stage is the experimental class of practice teaching and technician on probation. This has effectively promoted the teaching reform of the university and the improvement of comprehensive quality for the students.

KEY WORDS: Practice Teaching, Technician on Probation

In order to carry out the education policy of "Education serves the socialist construction and combines it with production", the universities and colleges in China highly pay attention to strenthening practice teaching and enhancing the comprehensive quality of the students.

The university-run factory is the base of combining with teaching, research and production for carrying out the education policy of the party and the country. It is not only a production entity, but also a teaching unit. Training the students into qualified personnel is the first task and glory duty of the university-run factory at any case. At present situation, giving full play to the mechanism of the university-run factory, opening up the function at practice teaching are the most important subject for deepening reform.

In recent years, there is a new development at the activity of practice teaching by means of multi-aspects of search and reform at the factory. This forms the new practice teaching with three stages and six forms and makes the teaching system mutual match and dovetail both front and back, compared with the original single "Manufacturing Practice".

The initial system of practice teaching is divided into three stages:

The First Stage: "Manufacturing Practice" And "Electronics Practice".

This stage is carried out among the students at the first and second grades. Machinery and Electronics are the two great foundations for the development of modern industry. It is very important for the future work of the students, who possess the fundamental knowledge and practice skills at the aspects of both machinery and electronics from the training targets of most of the majors in Tsinghua University. The factory has been offering "Electronics Practice" on the basis of "Manufacturing Practice" simce 1986. At present, "Electronics Practice" is brought into the teaching plan for most of majors as an obligatory course. The two practice courses can accept more than 1800 students from the first and second grades each year. The purpose of this stage is: teaching the basic technological knowledge, training the fundamental skills, proceeding the education of

thought style.

There are some new developments and breakthroughs at the fields of teaching containts and teaching methods by the continuous reform in recent years: expanding some typical technology by adding some experiments; carrying out elicitation method of teaching to develop the intelligence of the students and arouse them the study initiative; arranging some comprehensive training and some links of designing and making by themselves to train them the ability of both independently analyzing technical engineering problems and innovation. Centering on the education of thought style, we have been searching for some new links between different practice items. For instance, giving special topic on the analyzing technical economy, giving comments at practice field, summerizing the thought gains from practice, etc. "Electronics Practice" trains the students how to choose the suitable electronical elements and the skills of assembling, brazing and ajusting. According to the comments from the departments, there is a great difference at the aspect of ability for the students before and after practice training, especially when they work on the laboratory and on the graduation projects. An investigation about the graduates indicated that most of the graduates got the deepest impresion being from both manufacturing practice and graduation projects at the whole university training.

The Second Stage: "Technological Operating techniques" Elective Course And The Activity of Work–study Programme.

This stage is arranged mainly at the second and third grades. The purpose of "Technological Operating Techniques" is to encourage the students becoming the stronger of both fundamental theory study ability and practice ability. It is arranged on the basis of teaching the students in accordance with their aptitude. After finishing the "Manufacturing Practice" and "Electronics Practice", the first class students would be admmited on a voluntary basis.

There are four hundred study hours for this training. The students work on regular shifts at single type of work in production. There are some lectures on technological knowledge and self–lerning under the quidance at the same time. Finally, they should pass the exams of both "Technological Knowledge" and "Technical Skills" to reach the national standard of second grade technician. After that they can get second grade technician certificate and ten credit as well. One hundred and seventy four students have already passed the exams since 1986. One hundred students passed the exams in 1990. Two hundred students will pass the exams at the following years according to the plan. The figure will account for 10 percent among the whole students. The work study programme was originally organized for helping the students to solve their economical problem. But this time, the programme is stressed on the continuous comprehensive training on the basis of the former teaching practice. Combining the work–study programme with the training of second grade technician makes quite a part of students pass the exams of "Technical Operating Skills" elective course. This kind of arrangement is obviously much better than the work–study programme of the non–speciality production. So it is quite welcome by the students. No matter the "Technological operating Skills" or the work–study programme, the students very actively enter their names for the programme. But due to the limitation of the figure of the participants to be admitted, it is quite competitive for the students. After the admision, they would say, "I squeeze

the programme by competition."

Comparing with the first stage, the characteristics of this stage is that the students join the production work as ordinary works. They have the same right and the obligation as workers in production management, economic management. For example, carrying out the rules and regurations of "Remuneration by recording the finished components" and "compensation for going beyond the limitation of salvage", etc. The students work under the strict management and learn under the production. They have quite strong viewpoint of production tasks, viewpoint of economy, the consciousness of competition and benefit. And the whole practice activity is arranged at their spare time, evening, weekend, winter holiday or summer holidays. The hard work condition is advantageous to training the spirit of the students through arduous effort.

The practice teaching of this stage gives an impetus to the comprehensive quality for the students. They achieved better results than "Manufacturing Practice" and "Electronics Practice" at many aspects according to their own comments. They said that they had got not only the improvement of knowledge and ability, but also the viewpoint of production and economy from this stage training. They felt that it was not very easy to become a qualified worker. Some news medium also paid great attention to the newly emerging things. This was front-paged in "Youth Daily of China" with the heading of "Graduates with double cards". At the article the graduation certificate was termed as "Red Card", the certificate of second grade technician as "Blue Card". The relevant photograph was also appeared in "China Daily". At the assignment of graduation, the units of wanting the graduates had very high interests in those who hold the "Double Cards". They said that they welcome such students.

The Third Stage: Experimental Class on Practice Teaching And Technician of Probation.

The practice of this stage is arranged at high grade. The purpose of this stage is for the comprehensive fundamental training as earlier stage engineers. The students will organized to join the activity of production practice and the development of products, research projects and technological reform, etc., at the attached university-run factory.

At the first half year, the students of class 61 from forging speciality at the Mechanical Engineering Department went through the experiment of practice teaching for a whole term. The teaching experiment was divided into two stages. At first stage, they worked on regular shifts as ordinary workers. They undertook production task of the workshop together with workers. They took part in not only the task of batch production, but also the development of new product. At the process, the teacher systematically give theoreticallecture about 60 hours on machinery manufacturing technology. They mastered the operating skills very quick at the production process. After a period of time, most of the students could overfulfill the production quota. Some of them even could overfulfill three times of the quota. After 15 weeks training, the whole class, twenty two students all passed the exams of the second grade turner with excellent results. The first stage is the basis and also the prelude for the second stage. The students participated the development of product, the design, and manufacturing of new equipment as technicians at the second stage. At the middle and latter stage of participating production work, the students assigned to finish a certain design project or the task of the development of new product. They learn and prepare the de-

sign plan while working. They performed the design and manufacturing work within the last four weeks. The whole class finished the production quota over 6000 work hours, nineteen projects of design, manufacturing assembly and ajustment for equipment improvement, and a whole set of mechanical drawing for a rock drill measuring. The accumulated output value created by the students was more than thirty thousands yun within 19 weeks.

The gains of the students from half years practice education were in many aspects. Some of the students said, "I have learnt quite a lot from the half year's practice, especially understood that I would work at what the situation would be, and some more understanding of the real situation of our country. Only by being based on the present situation, having our feet planted on solid ground to bring the spirit of arduously doing pioneering work into full play, can we contribute our talent to change the backward situation of our country". And some other students said, "The best gain of the practice teaching for a whole term is that we begin to understand the workers, and we discover the simple and undorned nature and the spirit of disinterested offer from them, and find the mutual language with them." On the basis of summerizing the experience of class 61 (from forging speciality), the authority of the university made a decision to arrange the other three classes to continue the activity of practice teaching.

The another form of practice teaching at the third stage is that part of the students received the "Blue Card" were appointed as technician on probation. Under the guidance of the engineers, these students participate the development of products, research projects and technical reform programme at the workshop. Such a practice training gives a good result to enhance the comprehensive quality and work ability for the students. The appointed students have strong responsibility. They work hard and study intensively. They can be competent at the task before long.

The verious forms of activities at practice teaching have been developed for several years. This has effectively promoted the whole teaching reform of the university and the imprvment of comprehensive quality of the students.

The vast majority of students plunge into the practice teaching with immense enshusiasm. Due to the limitation of the base condition, the present situation is far from the requirement of meeting the needs of practice teaching.

We are going to try our best for further improving the practice teaching condition and further reform innovation to play an important role for training the students into qualified graduates in the attached university–run factory.

TEACHING OF PC-BASED CAD TO UNDERGRADUATES

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THE INDUSTRIAL CENTRE

The Industrial Centre (IC) of the Hong Kong Polytechnic was established in 1976 to provide technologist level students with industrial training. The main emphasis throughout the training is to integrate theory with practice and to provide as far as possible a real life industrial environment. At present the IC has more than 20 training areas/workshops covering a wide range of manufacturing machines and equipment, and a staff of 120 among which 60 are academic staff and 60 are technical support and administrative staff.

Students attend IC training in a so-called block-release mode of attendance, with one week as the basic unit of time (the normal length of a training module). During the training period the students are completely divorced from academic studies. The total number of modules an engineering student takes ranges from 10 to 26 depending the course of study, the average being about 16.

THE INDUSTRIAL CENTRE DRAWING OFFICE

The Industrial Centre Drawing Office provides Polytechnic engineering students with training in modern Drawing Office practice, with all drawings done on CAD. The Drawing Office training module is of 1 week (30 hours) duration. Students taking this module must have completed the pre-requisite of a 40 to 60-hour Engineering Drawing subject which is done on drawing boards (manual drafting). The IC Drawing Office offers training to about 600 full-time students, 100 part-time evening students, and 100 short course students. There is already a tendency to include CAD in the basic Engineering Drawing course so that among the 60 hours some 15 hours are on CAD. It is expected that in 3 years time the proportion of CAD in Engineering Drawing will further increase to about 40% (24 hours).

The Drawing Office has 3 academic and 2 technical support staff members involved in teaching.

DEVELOPMENT OF CAD FACILITIES IN THE IC DRAWING OFFICE

The IC Drawing Office started to use CAD in 1982 with 3 sets of Bruning Easydraf2 CAD systems running on HP9816 computers. This wasa 2-dimensional drafting system running on HP9816 computer and was selected because it possessed essential mechanical engineering drawing features, it was relatively cheap and also it was very user friendly. The implementation proved to be successful and a year later 3 additional identical sets were purchased.

In 1987 IBM gave a generous donation of US$1.4 million worth of CAD/CAM hardware and software to the Hong Kong Polytechnic to establish the IBM/Hong Kong Polytechnic CAD/CAM Research & Education Centre. The donation covers an IBM4341 mainframe computer with 3 IBM 5080 graphics monitors and other peripherals for running Mainframe CADAM, two IBM RT-PCs for running Professional CADAM, 15 sets of IBM 5500/5600 series computers for running MicroCADAM, two A0 size drum type plotters, five 24-pin dot matrix printers, and all related software packages.

Mainframe CADAM has 3-d wireframe and 3-d surfaces capabilities and can also do NC machine programming. MicroCADAM is basically a 2-d drafting system although it has the capability to generate isometric views. Professional CADAM is also a 2-d system except that it can handle more complicated drawing and supports higher resolution screens.

The 15 MicroCADAM systems have been used extensively for student training whereas Mainframe CADAM and Professional CADAM have been used mainly for R&D work.

Unfortunately the CADAM series was not popular in Hong Kong, and at that time there was not any CAM system which could be linked to MicroCADAM. Furthermore the IBM5500/5600 series computers are not general purpose computers and can hardly be used for running other software. In 1989 the Industrial Centre decided to acquire PC based CAD/CAM systems in sufficiently large quantities so that students could get systematic training in CAD, CAM and CNC machining.

The selection of hardware and software was based on the following criteria:

- Common hardware platform for various PC based CAD/CAM systems;
- Geometrical modeling capabilities;
- Compatibility with CAM systems;
- Popularity in local industry;
- User friendliness and learning curve profile;
- Standardization of PC based CAD/CAM systems within the Polytechnic;
- Cost.

Hardware selection was straight forward. The obvious choices at that time were PC/286 and PC/386. The latter was chosen since the price of PC/386 was at an acceptable level and more powerful. Twenty PC/386 computers were purchased. Now it is clear that this was a wise decision because recent upgrades of the CAD software packages which the IC is using run on PC/386 but not on PC/286.

The software selection process took much longer and involved a lot of demonstrations by dealers, evaluations, and discussions both within the Industrial Centre and with other departments in the Polytechnic. CADKEY was eventually selected because it has powerful 3d wireframe modeling capability, it is easy to learn, and the geometry data can be readily transferred to a CAM system called MASTERCAM (which the IC also acquired at a later stage). The only drawback with CADKEY was that it was not very popular in Hong Kong at that time. AutoCAD was, and still is, the most popular PC-based CAD system both in Hong Kong and worldwide. Our evaluation rated AutoCAD to be quite suitable for two-dimensional Civil/Building drawings. The final decision was to use CADKEY for Mechanical Engineering drawings and AutoCAD for Civil Engineering drawings. However these two CAD systems are not isolated. Data created with one can be transferred to the other through the CADKEY CADL format and AutoCAD DXF format.

CADKEY has since become the Industrial Centre standard for project work and the main stream CAD system for teaching. In 1990 the IC established a second CAD Room with another 20 PC/386. This was mainly to cope with the increasing training demand and basically the same software packages were used.

TEACHING AIDS

One of the IC CAD Rooms is equipped with a projection TV with a 2mx2m screen. The protection TV is interfaced with a computer so that whatever is displayed on the computer screen can be displayed simultaneously on the big screen. This set-up is considered to be invaluable for the teaching of CAD. A large group of students can all watch the instructor working on his computer and follow the same steps with their own computers.

The projection TV is also connected to a video tape recorder and can be used to show videos such as CADKEY self learning package.

The IC has also developed teaching material using graphics presentation software including Harvard Graphics and DRHALO. This replaces the conventional transparencies using overhead projectors and results in more convenient, lively and colourful presentations.

TRAINING DURATION

The training duration in the Drawing Office is constrained by the IC block release mode and is fixed at 30 hours. The speed of learning could vary from system to system depending mainly on the user interface. Our experience shows that within 10 to 15 hours of guided practice an average student can master the basic functions of CADKEY including some 3d functions. During the rest of the time students are given real work which are drawings of Industrial Centre projects.

BACKGROUND KNOWLEDGE IN ENGINEERING DRAWING

The IC Drawing Office offers CAD courses to both Polytechnic students and to people working in industry. The first type of students will have spent at least 40 hours Engineering Drawing on drawing boards before coming to the CAD room. The second type is in the form of short courses where there is no specific entry requirements. There are students coming to these short courses with no or very little knowledge of Engineering Drawing. It is discovered that the second type of students learn much slower than the first.

TWO STUDENTS ON ONE CAD STATION

Due to facility limitation it is sometimes necessary to put two students on one CAD station. This is not always undesirable as our experience shows that at the beginning of a CAD course students learn faster that way. Putting two students on one CAD station gives them the opportunity to discuss with each other. It is therefore the normal practice in the Industrial Centre to put two students on one CAD station, at least on the first day, even if there are spare computers.

CAD EXERCISES

The IC Drawing Office has prepared several standard CAD exercises. Each CAD exercise is designed in such a way that a few new functions are introduced. Before the students are given an exercise the lecturer will explain on blackboard the new functions involved and then actually do the exercise as a demonstration. This has proved to be an efficient way of teaching.

SELF LEARNING PROGRAMMES

The IC Drawing Office has also prepared self learning programmes on CAD so that even beginners can learn CAD without supervision. The self learning programmes are prepared in such a way as to instruct the students what to do step by step. If the student follows the steps carefully he can definite draw what he is expected to draw. Now comes two problems:

The first one is some students tend to follow the self learning programme without thinking about what he is actually doing. In the end he can complete the drawing but does not learn much out of it. What he has done is almost like a typist who types a long document without a single mistake but